

**Remarks**

Applicant has carefully considered the office action mailed March 24, 2009 and submits the following remarks.

**Rejection of claims 12-25, 29, and 30 for obviousness over APA in view of Chu, Cosyns, and O'Rear**

The examiner rejects claims 12-25, 29, and 30 as obvious under 35 U.S.C. § 103 over "Applicants' admitted prior art (APA) in view of U.S. Patent No. 4,471,145 to Chu et al. ("Chu"), U.S. Patent No. 4,471,145 to Cosyns, et al ("Cosyns"), and U.S. Patent No. 6,392,108 to O'Rear ("O'Rear").

**Response**

The claims are directed to "a process of operating an evaporator burner oven."

Claim 12, 20, and 31. All of the claims also now specify:

supplying fuel comprising Fischer-Tropsch derived fuel comprising Fischer-Tropsch product having a density of between 0.65 and 0.8 g/cm<sup>3</sup> at 15 °C to an evaporation surface of the evaporator burner oven.

Claims 12, 20, and 31 (emphasis added). Claim 20 has been amended to independent form, and new claims 31-34 have been added.

As explained in the specification, "[a]s a result of the low contents of aromatics and naphthenics compounds the density of the Fischer-Tropsch [derived] product will be lower than the conventional mineral derived fuels." Specification, ¶ [0013]. See also Table 1, Specification ¶ [0021] (Fischer-Tropsch kerosene density at 15 °C, 734.8 g/cm<sup>3</sup>; "Norway Kero" density, 810 g/cm<sup>3</sup>). Persons of ordinary skill in the art would understand that a lower density Fischer-Tropsch derived fuel product would have different evaporation properties than a comparable higher density petroleum derived fuel. See Exhibit A (Wikipedia excerpt). See also Wuest. Additional evaporative differences could be expected due to the differences in the fuel composition. *Id.*

Wuest explains that:

With kerosene or petroleum as fuel, it is possible, during burner start-up, to heat the kerosene or petroleum to the vaporization temperature in the vaporizing chamber by means of an electric heating device, but to subsequently switch off the electric heating device when the heating device together with the burner has

been heated up to such an extent that the vaporization of the kerosene or petroleum is maintained by the sensible heat of the heating device. **With extra light heating oil, however, continuous operation of the electric heating device is necessary on account of the much higher vaporization temperature with this fuel.**

Wuest, col. 1, ll. 51-62 (emphasis added). Wuest attempts to solve this problem by modifying the evaporation burner. According to Wuest, when his burner is used to burn “extra light heating oil,” “the vaporizing chamber has to be heated . . . only during the starting phase when the burner is cold, whereas the supply of external energy for heating the fuel is unnecessary during the subsequent operation of the burner.” Wuest, col. 2, ll. 19-24.

Particularly in domestic heating applications, it would inefficient, and might not be possible to modify or update existing vaporizer burners to use a burner such as Wuest’s. Rather than changing the burner, the present application supplies fuel comprising lower density Fischer-Tropsch derived fuel to the vaporizer burner. Applicant’s data demonstrates burning a fuel comprising a Fischer-Tropsch derived kerosene in a “Jotul 709 Oven (as manufactured by Jotul ASA in Norway) for 90 minutes” produced improvements “compared to burning petroleum derived kerosene in the same oven.” Example 1, Specification, ¶¶ [0021] -[0026].

The examiner has not established that supplying the claimed fuel to an evaporator burner oven was “**the predictable use of prior art elements according to their established functions.**” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. \_\_\_\_ 398, 127 S.Ct. 1727, 82 U.S.P.Q.2d 1385, 1396 (U.S. 2007) (emphasis added). Nor has the examiner established an apparent reason to combine known elements in **the fashion claimed.** *Id.*

The examiner argues that Corsyns states that “a liquid fuel derived from Fischer-Tropsch synthesis process has the same use as oil.” Office action, p. 3. The foregoing is not a teaching or suggestion to supply a fuel comprising Fischer-Tropsch derived fuel to any particular burner, much less to an evaporator burner oven. As seen from the foregoing discussion, particularly from the teachings in Wuest, the examiner has not established an apparent reason to combine known elements in **the fashion claimed.** *Id.* (emphasis added).

The examiner also argues that O'Rear states that "Fischer-Tropsch derived fuels have very low levels of sulfur and nitrogen, have excellent burning properties, and can be used as an environmentally friendly 'green fuel.'" Office action, pp. 3-4. The foregoing is not a teaching or suggestion to supply a fuel comprising Fischer-Tropsch derived fuel to any particular burner, much less to an evaporator burner oven. As seen from the foregoing discussion, particularly from the teachings in Wuest, the examiner has not established an apparent reason to combine known elements **in the fashion claimed.** *Id.* (emphasis added).

The examiner clearly has not established a reasonable expectation that supplying the claimed fuel comprising Fischer-Tropsch derived fuel to an evaporator burner oven could produce "increased efficiency compared to combusting a petroleum derived kerosene fuel under the same conditions using the same burner." Claims 20 and 31. Nor has the examiner established a reasonable expectation that, compared to combusting a petroleum derived kerosene fuel under the same conditions using the same burner, supplying the claimed fuel comprising Fischer-Tropsch derived fuel to an evaporator burner oven could produce: a reduced unburned hydrocarbon content; reduced carbon monoxide emissions; and/or a reduced Smoke Number. Claims 15-19 and 32-34.

Applicant respectfully requests that the amendments be entered and that the rejection be withdrawn.

#### Rejection of Claims 26 and 28

The examiner rejects claim 26 as obvious over APA, Chu, Cosyns, O'Rear, and further in view of U.S. Patent No. 3,607,074 to Brown et al. The examiner also rejects claim 28 as obvious over APA, Chu, Cosyns, O'Rear and further in view of U.S. Patent No. 4,932,979 to Thrasher et al.

#### Response

Claims 26 and 28 depend from allowable claims and are allowable therewith for all of the reasons discussed above.

**Rejection of claims 12 and 27 as obvious over  
Wuest in view of Chu, Cosyns, and O'Rear**

The examiner also rejected claims 12 and 27 as obvious over U.S. Patent No. 6,540,505 to Wuest ("Wuest") in view of Chu, Cosyns and O'Rear.

**Response**

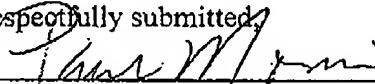
The discussion above applies equally to this rejection. For all of the foregoing reasons, the examiner has not established a *prima facie* case of obviousness of claims 12 and 27 over Wuest, Chu, Cosyns and O'Rear.

Applicant respectfully requests that the rejection be withdrawn.

**CONCLUSION**

For all of the foregoing reasons, Applicant respectfully requests entry of the amendments and allowance of the amended claims. The examiner is hereby authorized to charge any fees, and to deposit any overpayment of fees, to Deposit Account No. 19-1800 (File no. TS8579), maintained by Shell Oil Company

Respectfully submitted,

  
\_\_\_\_\_  
Paula Morris  
The Morris Law Firm, P.C.  
P. O. Box 42787  
10777 Westheimer, Suite 1100  
Houston, TX 77042  
Phone: 713/334-5151  
FAX: 713/334-5157  
ATTORNEY FOR APPLICANT

# Evaporation

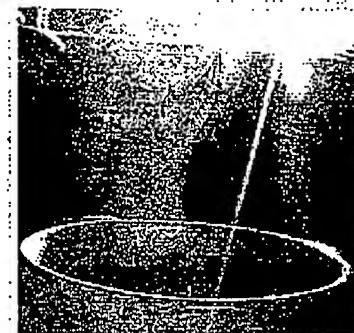
From Wikipedia, the free encyclopedia

**Evaporation** is the slow vaporization of a liquid and the reverse of condensation. A type of phase transition, it is the process by which molecules in a liquid state (e.g. water) spontaneously become gaseous (e.g. water vapor). Generally, evaporation can be seen by the gradual disappearance of a liquid from a substance when exposed to a significant volume of gas. Vaporization and evaporation however, are not entirely the same processes. For example, substances like caesium, francium, gallium, bromine, rubidium and mercury may vaporize, but they do not evaporate as such.

On average, the molecules in a glass of water do not have enough heat energy to escape from the liquid, or else the liquid would turn into vapor quickly (see boil). When the molecules collide, they transfer energy to each other in varying degrees, based on how they collide. Sometimes the transfer is so one-sided for a molecule near the surface that it ends up with enough energy to escape.

Liquids that do not evaporate visibly at a given temperature in a given gas (e.g. cooking oil at room temperature) have molecules that do not tend to transfer energy to each other in a pattern sufficient to frequently give a molecule the heat energy necessary to turn into vapor. However, these liquids *are* evaporating, it's just that the process is much slower and thus significantly less visible.

Evaporation is an essential part of the water cycle. Solar energy drives evaporation of water from oceans, lakes, moisture in the soil, and other sources of water. In hydrology, evaporation and transpiration (which involves evaporation within plant stomata) are collectively termed evapotranspiration. Evaporation is caused when water is exposed to air and the liquid molecules turn into water vapor which rises up and forms clouds.



Water vapor that has evaporated and disappeared from hot tea condenses into visible droplets. Gaseous water is invisible, but the clouds of water droplets are evidence of evaporation followed by condensation. It is in the water cycle

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## Theory

*See also: Kinetic theory*

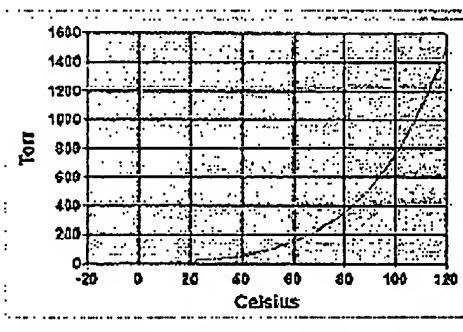
For molecules of a liquid to evaporate, they must be located near the surface, be moving in the proper direction, and have sufficient kinetic energy to overcome liquid-phase intermolecular forces.<sup>[1]</sup> Only a small proportion of the molecules meet these criteria, so the rate of evaporation is limited. Since the kinetic energy of a molecule is proportional to its temperature, evaporation proceeds more quickly at higher temperatures. As the faster-moving molecules escape, the remaining molecules have lower average kinetic energy, and the temperature of the liquid thus decreases. This phenomenon is also called evaporative cooling. This is why evaporating sweat cools the human body. Evaporation also tends to proceed more quickly with higher flow rates between the gaseous and liquid phase and in liquids with higher vapor pressure. For example, laundry on a clothes line will dry (by evaporation) more rapidly on a windy day than on a still day. Three key parts to evaporation are heat, humidity and air movement.

On a molecular level, there is no strict boundary between the liquid state and the vapor state. Instead, there is a Knudsen layer, where the phase is undetermined. Because this layer is only a few molecules thick, at a macroscopic scale a clear phase transition interface can be seen.

### Evaporative equilibrium

If evaporation takes place in a closed vessel, the escaping molecules accumulate as a vapor above the liquid. Many of the molecules return to the liquid, with returning molecules becoming more frequent as the density and pressure of the vapor increases. When the process of escape and return reaches an equilibrium,<sup>[1]</sup> the vapor is said to be "saturated," and no further change in either vapor pressure and density or liquid temperature will occur. For a system consisting of vapor and liquid of a pure substance, this equilibrium state is directly related to the vapor pressure of the substance, as given by the Clausius-Clapeyron relation:

$$\ln\left(\frac{P_2}{P_1}\right) = -\frac{\Delta H_{vap}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$



Vapor pressure of water vs. temperature.  
760 Torr = 1 atm.

where  $P_1, P_2$  are the vapor pressures at temperatures  $T_1, T_2$  respectively,  $\Delta H_{vap}$  is the enthalpy of vaporization, and  $R$  is the universal gas constant. The rate of evaporation in an open system is related to the vapor pressure found in a closed system. If a liquid is heated, when the vapor pressure reaches the ambient pressure the liquid will boil.

The ability for a molecule of a liquid to evaporate is largely based on the amount of kinetic energy an individual particle may possess. Even at lower temperatures, individual molecules of a liquid can evaporate if they have more than the minimum amount of kinetic energy required for vaporization.

But vaporization is not only the process of a change of state from liquid to gas but it is also a change of state from a solid to gas. This process is also known as sublimation but can also be known as vaporization.

### Factors influencing the rate of evaporation

## Evaporation - Wikipedia, the free encyclopedia

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### Concentration of the substance evaporating in the air

If the air already has a high concentration of the substance evaporating, then the given substance will evaporate more slowly.

### Concentration of other substances in the air

If the air is already saturated with other substances, it can have a lower capacity for the substance evaporating.

### Concentration of other substances in the liquid (impurities)

If the liquid contains other substances, it will have a lower capacity for evaporation.

### Flow rate of air

This is in part related to the concentration points above. If fresh air is moving over the substance all the time, then the concentration of the substance in the air is less likely to go up with time, thus encouraging faster evaporation. This is the result of the boundary layer at the evaporation surface decreasing with flow velocity, decreasing the diffusion distance in the stagnant layer.

### Inter-molecular forces

The stronger the forces keeping the molecules together in the liquid state, the more energy one must get to escape.

### Pressure

In an area of less pressure, evaporation happens faster because there is less exertion on the surface keeping the molecules from launching themselves.

### Surface area

A substance which has a larger surface area will evaporate faster as there are more surface molecules which are able to escape.

### Temperature of the substance

If the substance is hotter, then evaporation will be faster.

### Density

The higher the density, the slower a liquid evaporates.

In the US, the National Weather Service measures the actual rate of evaporation from a standardized "pan" open water surface outdoors, at various locations nationwide. Others do likewise around the world. The US data is collected and compiled into an annual evaporation map.<sup>[2]</sup> The measurements range from under 30 to over 120 inches (3,000 mm) per year.

## Applications

When clothes are hung on a laundry line, even though the ambient temperature is below the boiling point of water, water evaporates. This is accelerated by factors such as low humidity, heat (from the sun), and wind. In a clothes dryer hot air is blown through the clothes, allowing water to evaporate very rapidly.

### Combustion vaporization

Fuel droplets vaporize as they receive heat by mixing with the hot gases in the combustion chamber. Heat (energy) can also be received by radiation from any hot refractory wall of the combustion chamber.

### Film deposition

Thin films may be deposited by evaporating a substance and condensing it onto a substrate.

### See also

- Atmometer (evaporimeter)
- Crystallisation
- Desalination
- Distillation
- Drying
- Evaporator
- Evapotranspiration
- Flash evaporation
- Heat of vaporization
- Latent heat
- Pan evaporation
- Transpiration

		To		
From	Solid	Liquid	Gas	Plasma
Solid	Solid-Solid Transformation	Melting/Fusion	Sublimation	N/A
Liquid	Freezing	N/A	Boiling/Evaporation	N/A
Gas	Deposition	Condensation	N/A	Ionization
Plasma	N/A	N/A	Recombination/Deionization	N/A

## References

- Sze, Simon Min. *Semiconductor Devices: Physics and Technology*. ISBN 0-471-33372-7. Has an especially detailed discussion of film deposition by evaporation.

1. ^ <sup>a</sup> <sup>b</sup> Silberberg, Martin A. (2006). *Chemistry* (4th edition ed.). New York: McGraw-Hill. pp. 431–434. ISBN 0-07-296439-1.
2. ^ Geotechnical, Rock and Water Resources Library - GROW Resource - Evaporation

## External links

- MSN Encarta article on evaporation
- Evaporation of water

Retrieved from "<http://en.wikipedia.org/wiki/Evaporation>"

Categories: Atmospheric thermodynamics | Basic meteorological concepts and phenomena | Materials science | Phase changes | Thin film deposition

Hidden categories: Physics articles needing expert attention | Articles needing expert attention from November 2008

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